World-class experimental platform for Smart Grid development

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PowerLabDK

World-class experimental platform for Smart Grid development

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Smart Utilities Scandinavia
Copenhagen

PowerLabDK

World-class experimental platform for Smart Grid development

Technology development
Research & education
Demonstration
Testing

www.powerlab.dk

DTU Technical University of Denmark

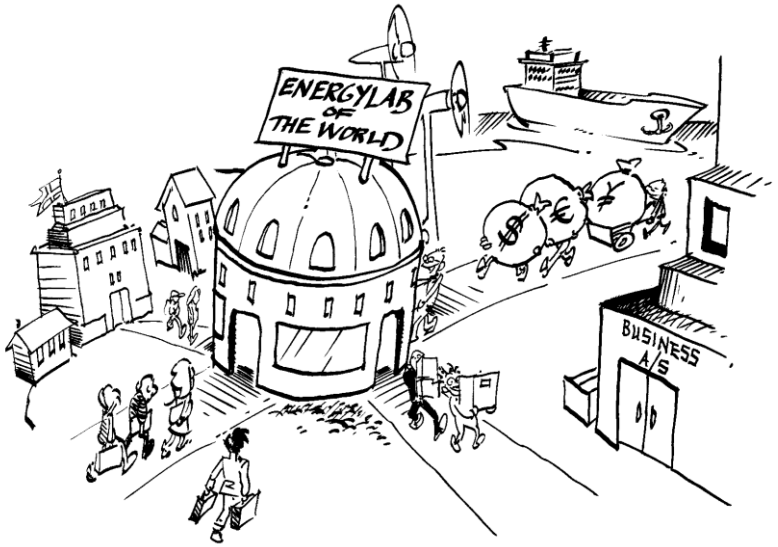
INGENIØR HØJSKOLEN KØBENHAVN – University College

ØSTKRAFT energi til gode oplevelser

PowerLabDK addresses challenges of our society

- The climate challenge
- Transformation of the energy system is needed and requires new innovative solutions
- Green growth, jobs and export. Denmark as global Smart Grid hub.

- PowerLabDK supports this development
  - Experimental platform
  - Collaboration platform
  - Platform for education



PowerLabDK combines experimental facilities in several locations

IHK (high-power)

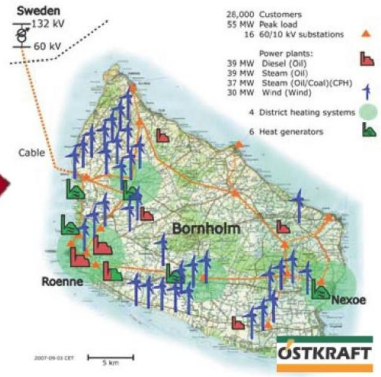
DTU Elektro building 329

Flexible multi-purpose research laboratory

Large-scale test system

Risø DTU (SysLab)

Full-scale power system



Østkraft (Bornholm)

Stakeholders:

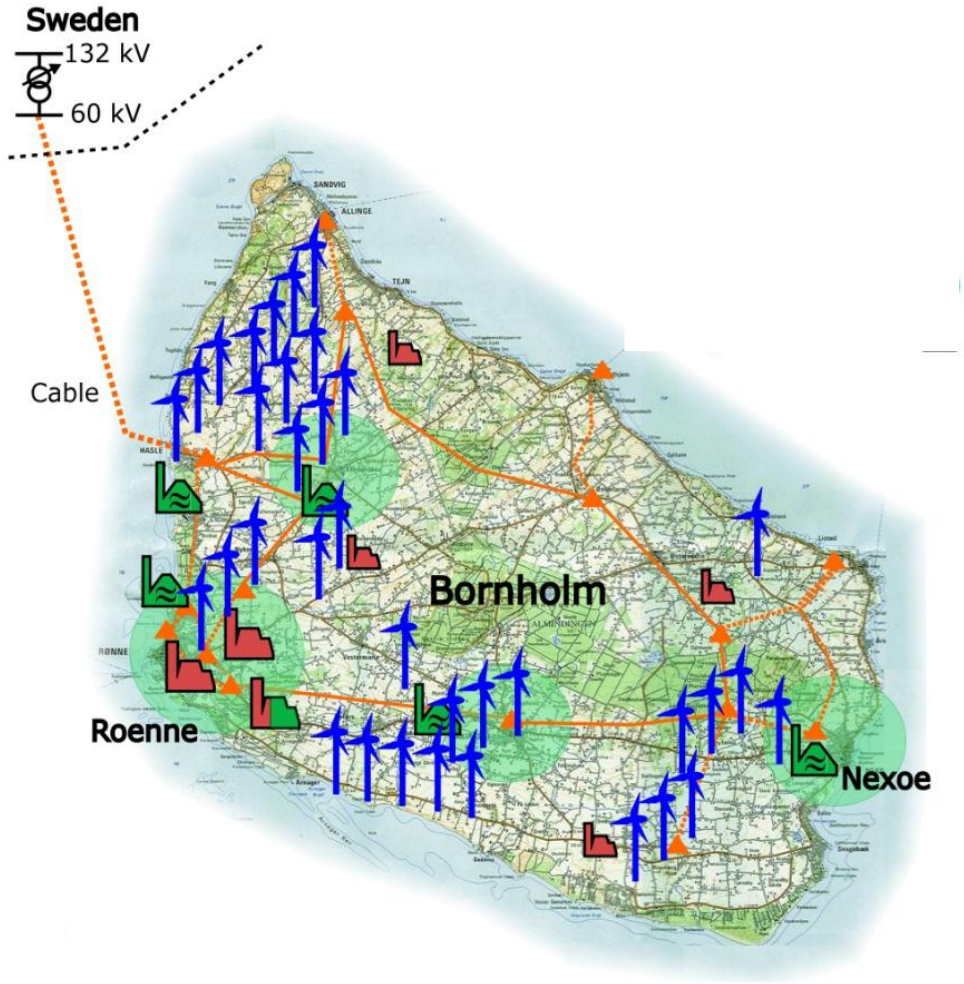
ABB, nkt cables, dansk energi, SIEMENS, DONG energy, VATTENFALL, ENERGINET.DK, Vestas, IBM

Supported by:

GREEN LABS DK, EUDP

Investment:
18 million Euro

Bornholm Power System with 33% wind power penetration



Full-scale laboratory for Smart Grid test and demonstration

BRIGHT GREEN ISLAND
BORNHOLM

PowerLabDK

SYSLAB and PowerFlexHouse

Intelligent distributed energy system in practice

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Intelligent Control Lab

Power system simulation, control and supervision

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ØSTKRAFT
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Electric Lab

Power and energy technologies for the intelligent grid

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Integrated experiments

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High Voltage, High Power and Student Labs

Components in interaction with complex energy systems

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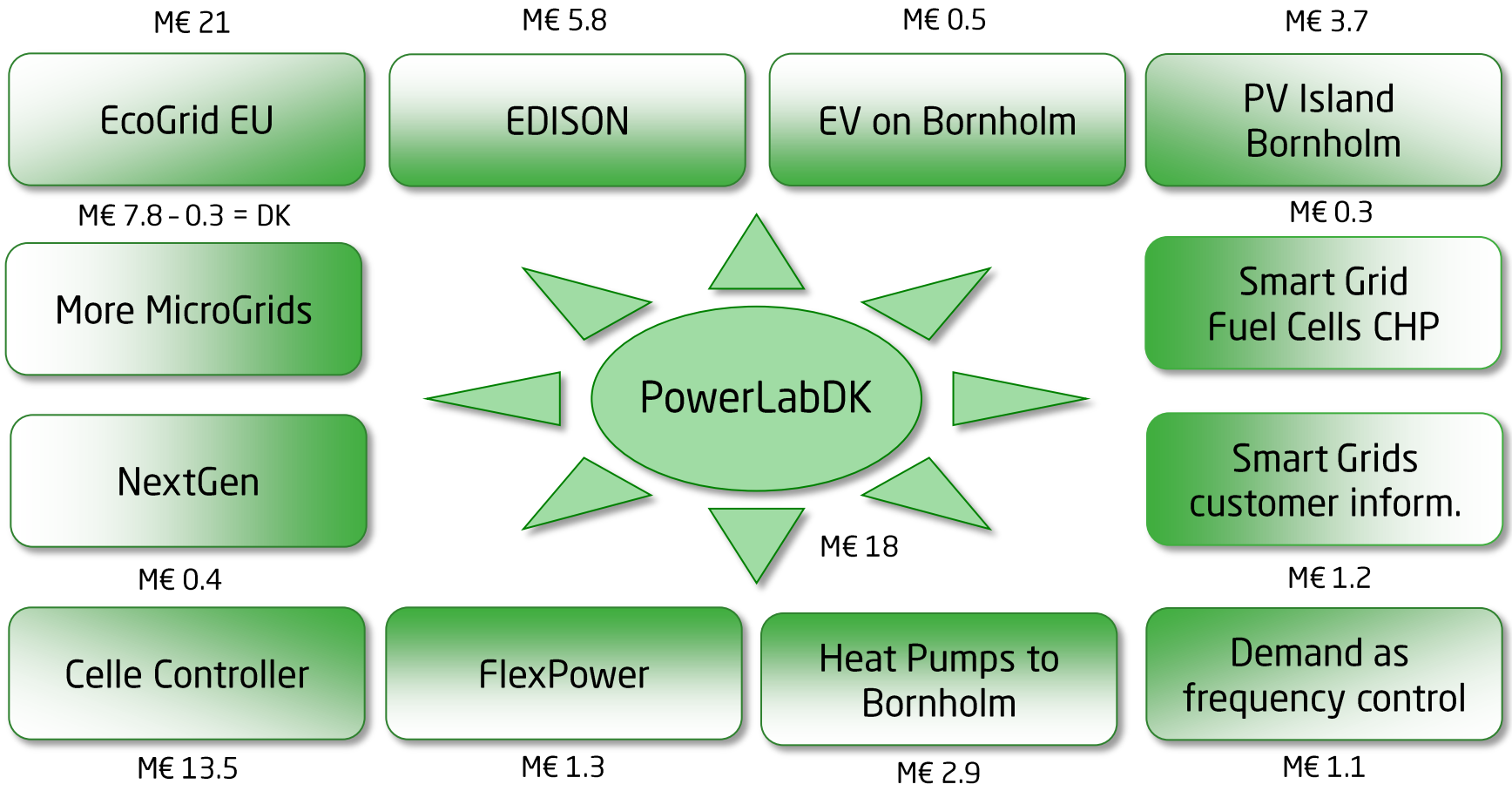
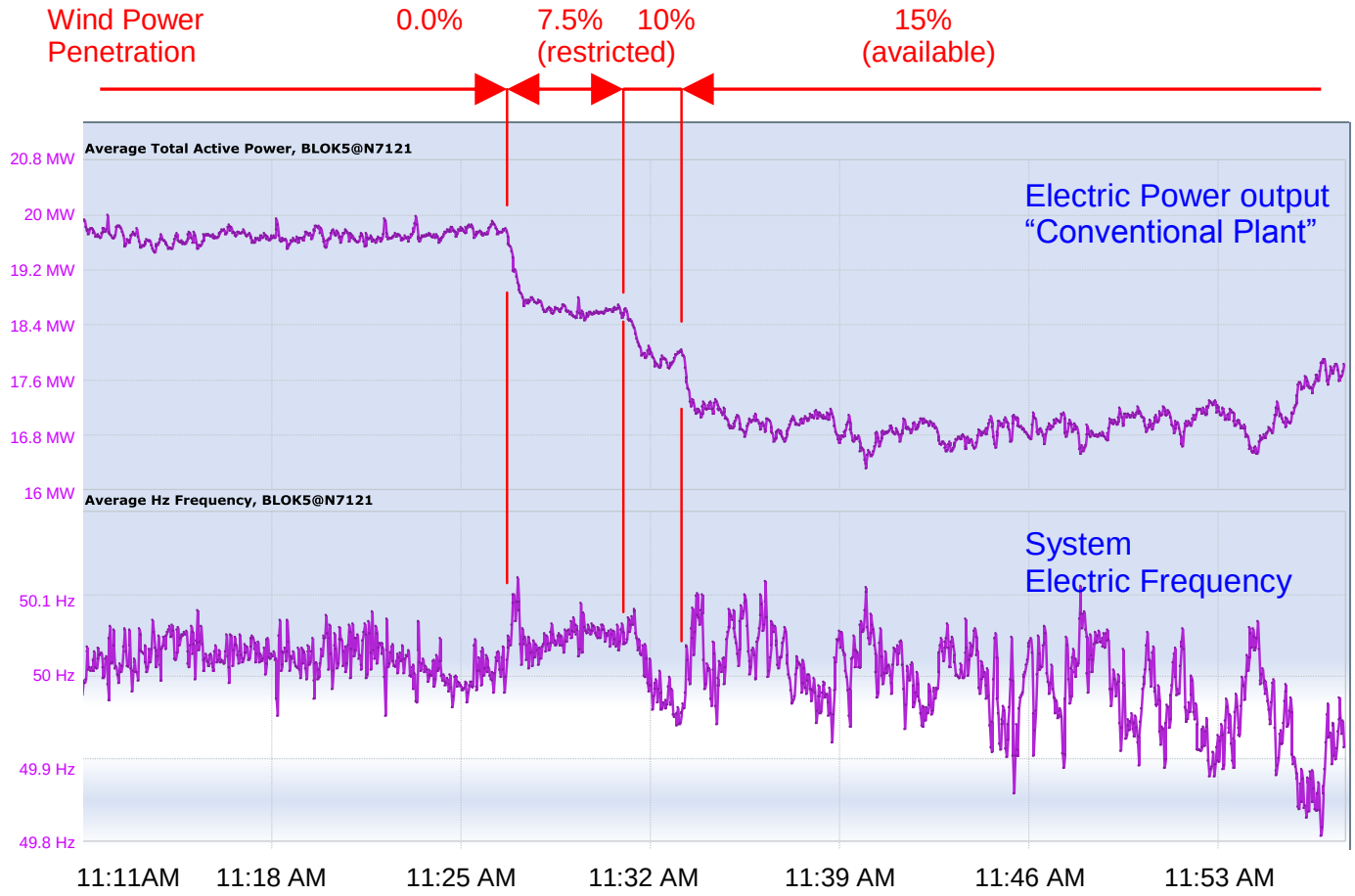
Research projects at Bornholm



Some M€ 40 funding to Bornholm projects based on PowerLabDK

Bornholm Island Operation

17 September 2009



Coordinated regulation of wind power

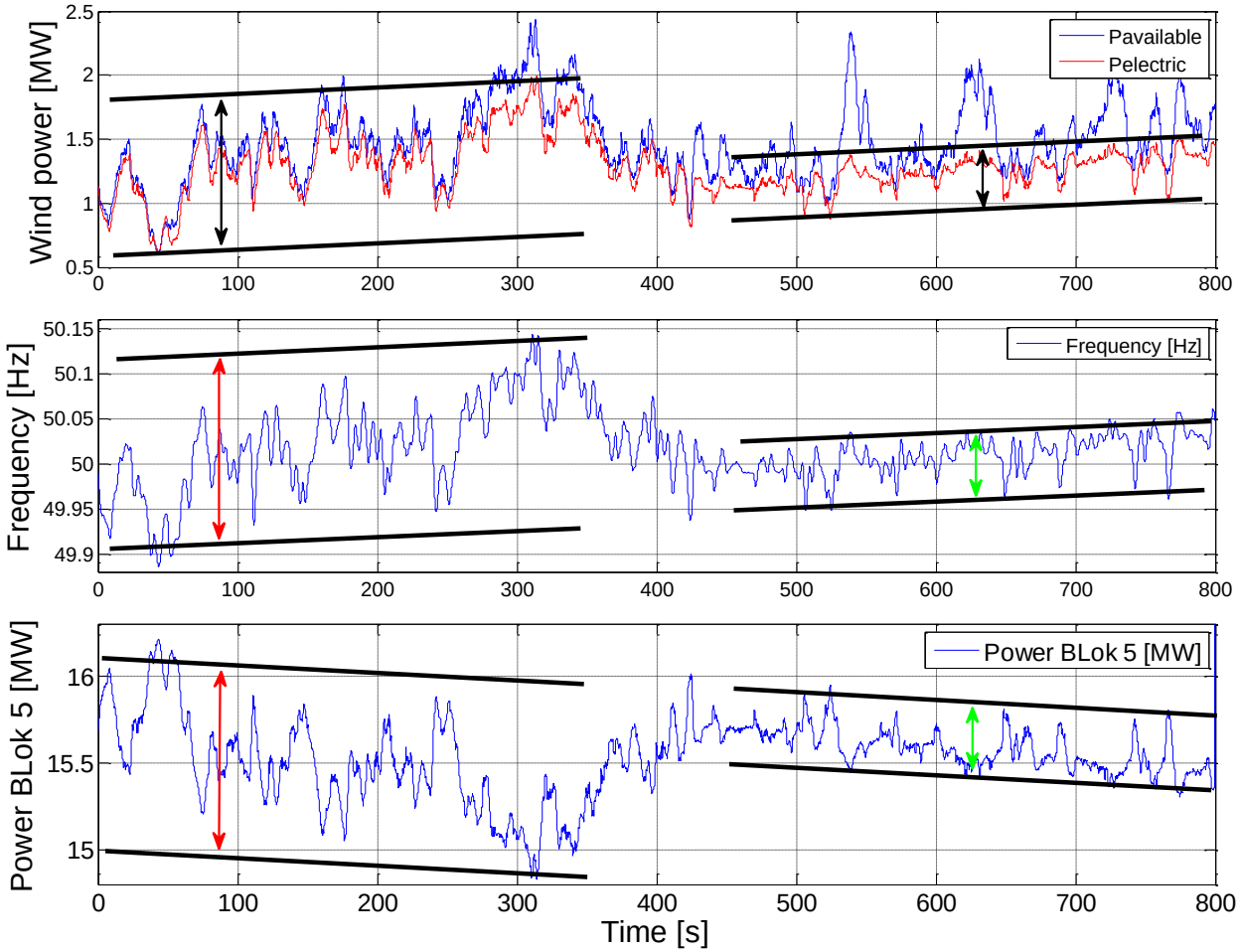
Bornholm islanding

1. Wind fluctuations affect frequency and power from steam turbine (red arrows)

2. Wind turbines can be controlled to automatically reduce the fluctuations to a safe level (green arrows)

3. Safe level is specified according to number of "Governors" on-line

4. Wind turbines can operate in island mode continuously while adjusting automatically the power to a safe level but maximizing yield

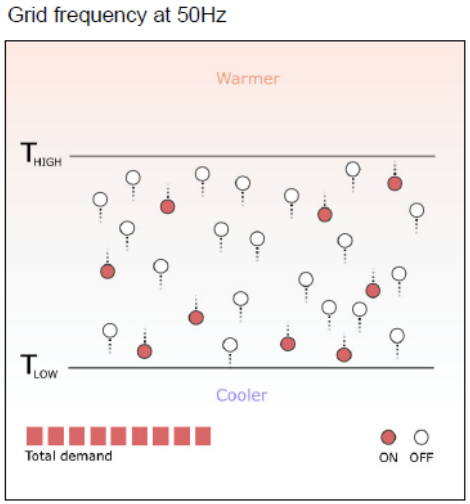


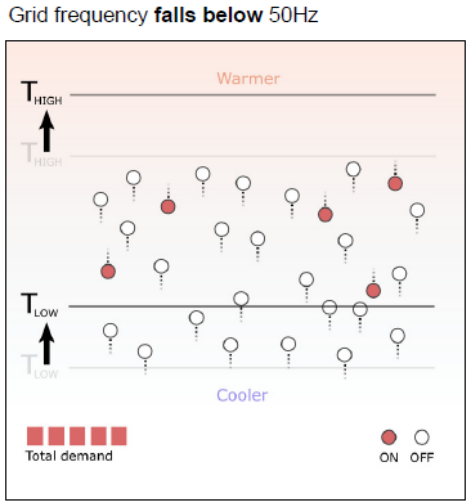
Frequency

Demand as frequency controlled reserve (DFCR)

Large share of the demand can be disconnected in a short period wo. problems

- heat
- cooling
- pumping
- EV charing
- ...

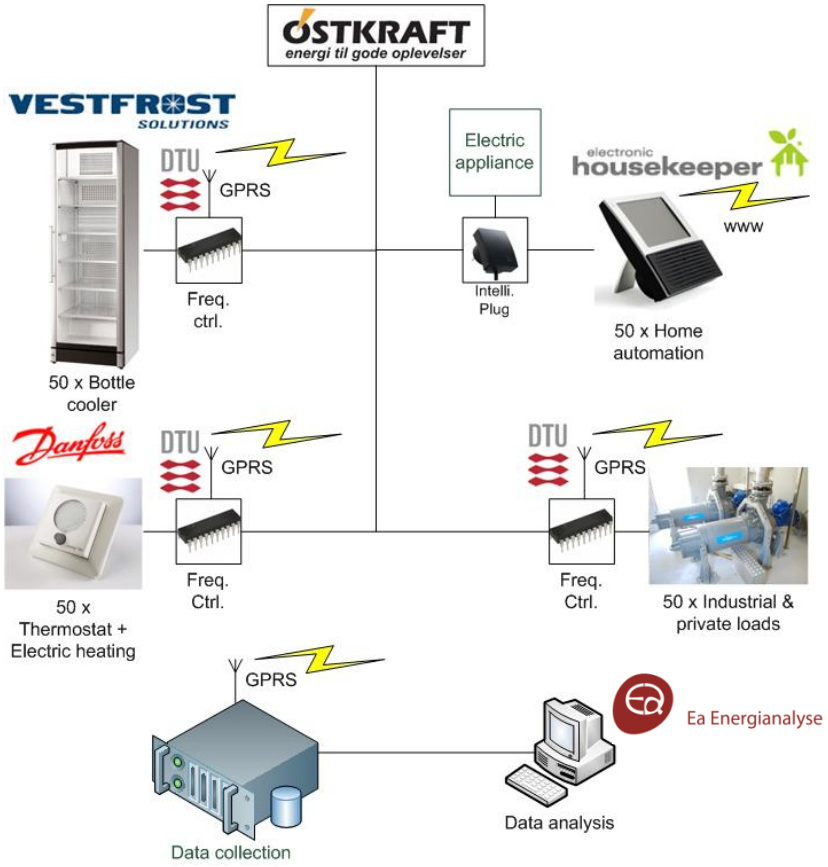




$$T_{high} = T_{high}^{normal} - kf(f - f_0)$$

$$T_{low} = T_{low}^{normal} - kf(f - f_0)$$

Field Test with 200 Frequency Controlled Demand Units



Frequency reserves (2008)

- 22.000 €/MW/år (i DK2)
- 8.000 €/MW/år (i DK1)

Price per unit 20 €

- Simple pay pack time = **1-2½ y.** w/ 1 kW unit

Ref: IEEE Transactions on Power Systems, 2011.

Projektet er støttet af EUDP-programmet.

PowerLabDK

EcoGrid EU

Large-scale demonstration of the future intelligent distribution system

EU FP7 ENERGY

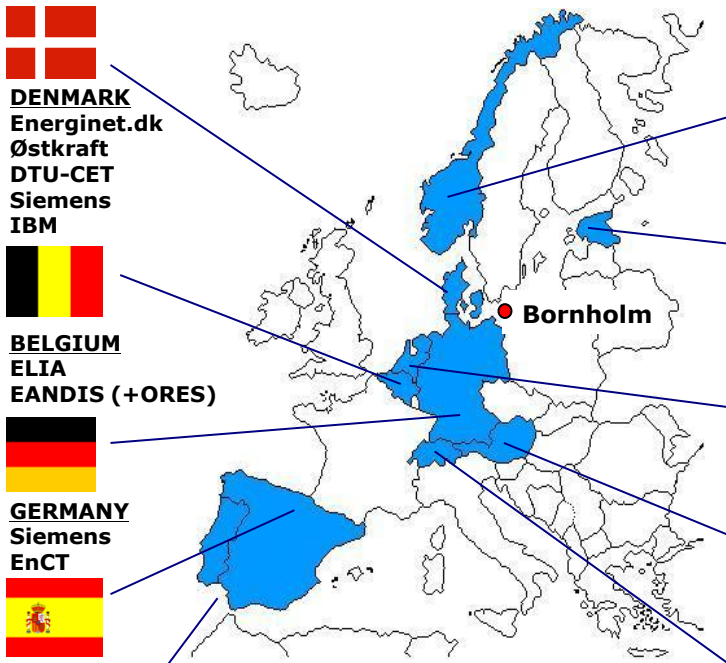
2011-14

Budget: 21 million Euro

Integrated research and demonstration

~2,000 participating customers

EU fast-track to Smart Grids



DENMARK
Energinet.dk
Østkraft
DTU-CET
Siemens
IBM

BELGIUM
ELIA
EANDIS (+ORES)

GERMANY
Siemens
EnCT

SPAIN
Tecnalia

PORTUGAL
EDP

NORWAY
SINTEF ER
(Coordinator)

ESTONIA
Tallin University of Technology (TUT)

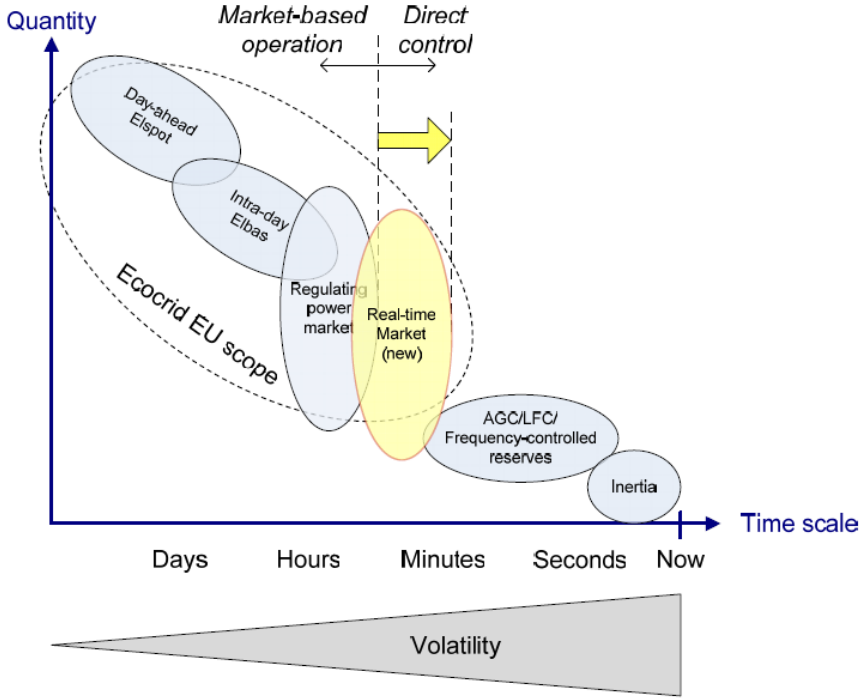
THE NETHERLANDS
ECN + TNO
IBM Benelux

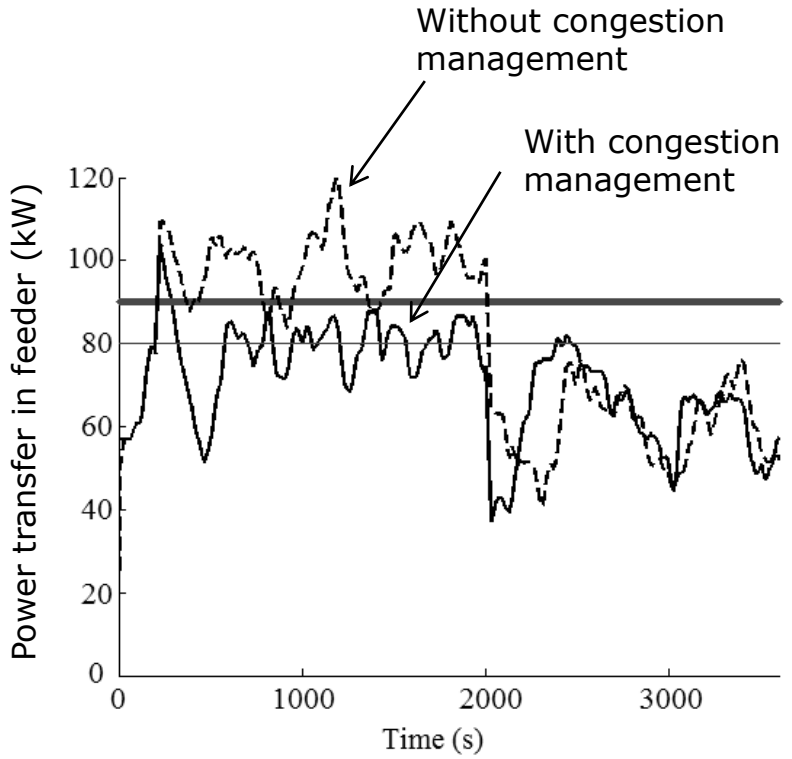
AUSTRIA
Austrian Institute of Technology (AIT)

SWITZERLAND
IBM Research
Landis+Gyr

EcoGrid EU real-time market solutions

Smaller Units and Shorter Time Constants / Congestion management





Presented at: IEEE ISGT Europe 2011.

PowerLabDK

Welcome to PowerLabDK

World-class experimental platform for technology development, testing, demonstration, research and training.

Open for all. Self-service. Full-service. You decide.

Application

- Electric equipment test
- Renewable energy sources
- Wind power development
- Smart Grid solutions
- Demand side technologies
- Heavy simulations
- Power system control
- Real-life experiments

Thank you - read more at www.powerlab.dk

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